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## Effect of a Stable First List on Transfer and "Fate" of First-List Associations

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**EFFECT OF A STABLE FIRST LIST ON TRANSFER AND  
"FATE" OF FIRST-LIST ASSOCIATIONS**

Fronke, M

by  
**Madeline Fronke**

**Dissertation Presented to the Faculty of the Graduate  
School of Loyola University of Chicago in Partial  
Fulfillment of the Requirements for the  
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## LIFE

The author, Madeline Fronke, was born May 11, 1928 in Kansas City, Missouri.

She was graduated from St. Teresa Academy in Kansas City in May, 1945. She began her undergraduate studies at Avila College, Kansas City, in September, 1945, and graduated cum laude from Fontbonne College, St. Louis, Missouri, in May, 1956. She began her graduate studies at Loyola University in September, 1956 and received the degree of Master of Arts in February, 1961. In 1967, she received an appointment as research assistant at Indiana University and attended Indiana University until February, 1969. In February, 1969, she entered Loyola University and continued work toward the degree of Doctor of Philosophy in psychology.

From 1950 to 1961, she taught in elementary schools in St. Louis, Missouri and Chicago, Illinois. In 1961, she received an appointment as instructor in the Department of Psychology and Director of Guidance at Fontbonne College in St. Louis. She was promoted to Assistant Professor in 1962 and was awarded tenure in 1969. From September, 1970 to August, 1971 she held a traineeship at the Loyola Child Guidance Clinic. From November, 1971 to June, 1972, she was an Associate School Psychologist in the elementary and senior high schools in the Milwaukee Public Schools. From August, 1972 to the present, she has been Chief Psychologist at the Demmer-Kiwanis Children's Division of the Curative Workshop of Milwaukee.

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## CHAPTER I

### REVIEW OF THE LITERATURE

Transfer, a learning phenomenon which incorporates the measurable effects of past learning on present acquisition has long been a central issue for verbal learning theory and research. The emphasis, historically, has been on the measurement of gross transfer effects (Ellis, 1965). More recently researchers have been directing their attention to analyzing gross transfer effects into various mechanisms which contribute their own measurable effect to the over-all transfer effect (Kausler, 1966). Currently, there is evidence of a shift from the traditional stimulus-response-association viewpoint to an exploration of the perceptual aspect of the input-output system of information processing (Asch, 1968; Martin, 1971).

Whatever the emphasis, transfer is central to verbal learning laws and processes and reflects the central position that these laws and processes hold in relation to other areas of learning. This is particularly evidenced in the innumerable applications transfer laws, developed in the laboratory, are finding in real life outside the laboratory (Kausler, 1966).

One of the basic tenets of laws of transfer is interference theory with its corollary, the extinction hypothesis. Currently there is growing evidence that interference-extinction theory, though generally successful in predicting outcomes in traditional laboratory tasks (Postman, 1961b), has only limited success in predicting outcomes for extra-laboratory tasks (Jung, 1968; Postman, 1963a; Underwood &

Ekstrand, 1966). This recently acknowledged limitation of the theory, together with the discrepancies found (Bugelski & Cadwallader, 1956; Dallett, 1962; Wimer, 1964) in utilizing Osgood's transfer surface (1949) which incorporates the primary laws of transfer; the complex roles played by degree of learning and meaningfulness parameters which as yet have no theoretical explanation (Martin, 1965); and the contradictory findings particularly in degree of learning studies (Mandler & Heinemann, 1956; Postman, 1962; Solso, 1969) suggest an area of research the exploration of which may yield data to explain these limitations, discrepancies, and contradictions. Jung (1970), in finding that second list associations could be learned even in the presence of the first list, suggested that verbal learning theorists may have to find an explanation other than extinction to describe the process occurring during a transfer task.

#### Development of the Unlearning Hypothesis and Associative Interference Theory

The modern formulation of the associative interference theory is a combination of several theoretical positions (Martin, 1971). Originally associative interference theory combined the ideas of associative inhibition (Muller & Schumann, 1894, cited in Martin, 1965, p. 327) and retroactive inhibition (Muller & Pilzecker, 1900, cited in Martin, 1965, p. 327). The idea of associative inhibition is that learning one response to a stimulus makes the learning of a second response to the same stimulus more difficult. This is the familiar negative transfer effect in the A-B, A-C transfer paradigm (A-C). In the case of retroactive inhibition, after one response is learned to a stimulus and

then a second response is subsequently learned to the same stimulus, the performance of S when required to return to the first response is poorer. The interpolated learning interferes with the original learning. According to associative interference theory, associations compete to produce one or the other response to the single stimulus.

Webb (1917) introduced a two-factor theory which combined and modified the idea of associative inhibition and associative interaction. To understand Webb's theory better, it will help to couch it in symbolic terms. The stimulus will be represented by the letter A. The first response to be learned will be represented by the letter B. The second response to be learned will be represented by the letter C. After B is learned to A in the first learning task, the initiation of the second task of learning C to A, the same stimulus, disorganizes the original association of B to A. This is the first factor of Webb's two-factor theory, namely, that of weakening the original learning of B to A (A-B). When S is required to return to the learning of A-B, C is reinstated by the presentation of A and competes with the emitting of B to A. This formulation is recognized as a retroaction design. Stated as a transfer design, learning B to A prior to learning C to A makes B the competing response which interferes with the emission of the C response. This is the second factor of Webb's two-factor theory, namely competition of responses.

McGeoch (1942) proposed that only the second factor of Webb's two-factor theory was necessary. Responses are not lost but there is a competition between responses B and C with one response acquiring momentary dominance over the other response and suppressing it. In

other words, A-C learning does not weaken the A-B association. Rather after A-B, A-C learning, A can still evoke either B or C. Which one is emitted depends on which one is dominant.

Melton and Irwin (1940) tested the implication in the dominance hypothesis that the frequency of C intrusions in a test for recall of original learning should co-vary with the amount of retroaction. They found that this is not the case. The results of their experiment led them to the conclusion that unlearning of the A-B association during A-C learning does take place. On the basis of this finding, Webb's first factor was reinstated.

Underwood (1948a) tested A-B relearning after A-C interpolated learning and found a greater number of correct B responses on the first trial of relearning after a 48-hour interval than after a 5-hour interval. This looked like the well-known phenomenon of spontaneous recovery which occurs when a time interval elapses after the last extinction trial in a conditioning experiment. Underwood (1948b) proposed that verbal associations are unlearned and then recover some of their strength after a period of time elapses.

Briggs (1954) tested the extinction or unlearning hypothesis by using a retroactive inhibition (RI) paradigm with two lists of 12 paired adjectives having common stimulus terms. Each S learned the first list to a criterion of one perfect trial. The second, interfering list was learned to the same criterion 24 hours later. Subgroups of Ss then relearned the original list after retention intervals of 4 minutes, 6, 24, 48, or 72 hours. The important innovation to point out, for the purposes of this study, is that throughout original and interpolated learning, Briggs used test trials of modified free re-

call (MFR). In MFR the stimulus terms are presented alone. S is asked to give the first response that comes to mind, but only one response. The MFR leaves the subject free to give any response from either list, or from outside the list if he wishes. The frequency of the type of response reflects its relative strength. The MFR test was given after 3, 6, 9, or 12 responses had been given correctly. Results clearly show that as number of correct responses for List 2 increases, number of correct response recalls for List 1 steadily declines.

Briggs (1957) did a more comprehensive study by manipulating both A-B and A-C list learning and plotted RI as a joint function of the two variables. Amount of interpolated learning (A-C or transfer list) was defined in terms of number of trials on the A-C list. Lists of 10 paired adjectives were used. The originally learned A-B list was given either 2, 5, 10, or 20 trials. The A-C list was given either 0 (control), 2, 5, 10, or 20 trials. This was followed by recall of the A-B list by the MFR method. Results showed that recall of responses on the A-B list increased as amount of practice decreased. Results also showed that increasing the amount of A-C learning increased the amount of A-B extinction and lowered recall. Briggs used an extinction theory to account for the decline in recall of first-list responses as learning of second-list increased.

However, Briggs, using his MFR technique, allowed for only one response to the stimulus. Thus his data could support either an unlearning theory or a competition-dominance theory. In the experiment, S learned A-B and A-C. On the recall task, he was given the opportunity

to produce only one response. It is possible that S then gave the dominant response and still had available the non-dominant response. Because of the inadequacy of his instrument, Briggs did not have information as to the availability status of the non-dominant response.

Barnes and Underwood (1959) in a now classic experiment remedied this defect by introducing a modification of the MFR technique (MMFR). They were the first to investigate formally what happens to first-list responses and associations as a second list is acquired. The purpose of the study was to evaluate three theories concerning the "fate" of first-list associations in learning a second list. It is relevant here to present the three theories and the results and conclusions reached by Barnes and Underwood. The first theory was the unlearning or extinction hypothesis. This theory was presented earlier in this paper. The second theory was an independence or list differentiation hypothesis. This theory proposes that the system of associations in the first list remains relatively intact during second-list learning and that as second-list associations are learned, an independent system of associations is established for the second list. The third theory was a mediation hypothesis. This theory proposes that after first-list responses and associations are learned, the first-list response becomes a mediator for learning second-list responses and associations.

Barnes and Underwood used A-B, A-C (A-C) and A-B, A-B' (A-B') paradigms. They modified the modified free recall (MMFR) of Briggs' study (1954) by stopping groups of Ss at different points in the learning of the second list and asking them to attempt to recall first-list and second-list responses for each stimulus. The lists were eight

paired-associates with CVCs as stimuli and adjectives as responses. Both lists had the same stimuli. All Ss learned the first list to a criterion of one perfect trial and four groups practiced the second list for 1, 5, 10, or 20 trials before the MMFR test. The procedure for the MMFR was written recall. The answer sheet had the eight stimuli printed on it and spaces to write the two responses associated with each stimulus. The Ss were told to write the responses as they came to mind making no attempt to recall one list first and then the other. Following this, Ss were asked to go through the responses they had written and attempt to indicate whether they were from the first list or the second list. To be given credit, the response had to be correctly recalled and identified with its proper list. Even when given a chance to occur on the MMFR test, first-list responses showed a decline as a function of second-list learning. Results from the study for the A-C paradigm supported an extinction or unlearning theory to account for the "fate" of first-list associations. Results for the A-B' paradigm supported a mediation theory without ruling out some unlearning of A-B associations. On the basis of this study, the hypothesis has been generally accepted that as second-list acquisition is progressing, the first list is being unlearned through a process of extinction. Considerable research on unlearning followed the Barnes and Underwood (1959) study providing supporting evidence for extinction theory (Garshaf & Sandak, 1964; Garshaf, Sandak, & Malinowski, 1965; Goggin, 1963; McGovern, 1964).

The unlearning-recovery hypothesis seemed then to account for the observed data more readily than the competition-dominance hypothesis. Hence, it was generally accepted that a stimulus does not have two different responses associated with it at the same time. As second-list learning progresses, the first list is unlearned. The recovery aspect of the theory proposes that after a period of time, if first-list associations are not obliterated completely, they will recover in strength and compete with second-list associations. This part of the theory is in agreement with McGeoch, the only difference being that McGeoch says that competition-dominance obtains throughout second-list learning whereas unlearning-recovery theory says that it obtains only in the recovery stage after first-list associations are initially extinguished.

All of these theoretical positions paved the way for the modern formulation of associative interference theory which combines McGeoch, Melton, and Underwood (Martin, 1971).

In a symbolic representation, the theory proposes that: 1) B is learned as an associative of A (A-B) in original learning; 2) C is learned as an associative of A (A-C) in a second task; 3) as A-C learning is taking place, it weakens the A-B associations of the original learning so that these A-B associations become increasingly unavailable; 4) as time elapses, A-B associations recover to some extent so that when A is presented, B and C compete for emission; and 5) the response emitted in this recovery period, B or C, is determined by the relative associative strengths of A-B and A-C.



As was noted, the MFR technique of Briggs (1954) for data collection was inadequate to determine if first-list responses were still available. Barnes and Underwood modified this technique by giving Ss the opportunity to give both first-list and second-list responses to the stimulus. Their data showed that first-list responses declined in recall during second-list learning producing a curve similar to the familiar extinction curve. This confirmed the Briggs' data and supported an extinction or unlearning explanation for the "fate" of List 1 responses. However, just as Briggs did not allow for two responses on the recall task (MFR), Barnes and Underwood did not allow for partial responses. Recent research, on the way in which responses are acquired and associated, suggests that the MMFR technique for measuring availability of List 1 responses is not sensitive enough (Crothers, 1962; Wichawut, 1970; Peterson & Peterson, 1959).

Peterson and Peterson (1959) determined the dependent probabilities that letters would be correct given the event that the previous letter of a consonant syllable was correct. They regarded consonant syllables as a serial learning task. They hypothesized that unrelated components would develop serial dependencies through repetitions until, as with familiar words, they become single units. Improved retention is attributed to increases in these serial dependencies. The data showed that with increasing repetitions, serial dependencies increase.

These results suggest that the first letter of a consonant syllable would be overlearned relative to subsequent letters and would be

more resistant to extinction. The MMFR technique allows only for the complete syllable to be scored correct on List 1 and List 2 recall. Hence, Barnes and Underwood can conclude only that the intact, complete responses from List 1 are increasingly unavailable as List 2 is learned. Their MMFR technique is not sensitive to partial responses which may still be retrievable during List 2 learning and either interfere with or facilitate transfer during initial, intermediate and/or final stages of the transfer task.

Crothers (1962) and Wichawut and Martin (1970) have shown that though paired-associate learning has been logically analyzed into two stages (Underwood, Runquist, & Schulz, 1959), as an element of one of the pairs is being learned, it begins to associate with the second of the pairs so that the second of the pairs becomes a mediator for the learning of the remaining elements of the consonant syllable being learned. In view of these findings, the first element of a consonant syllable would be overlearned in relation to the remaining elements and would be more strongly associated with the second consonant syllable of a pair. It is possible it could be evoked on a recall task as a partial response even though the whole syllable is not available.

As Solso (1969) puts it, Ss may retain only a fraction of the original response item and use that fraction as a tactical cue during second list learning.

Until a more sensitive instrument is devised, a more complete account of the 'fate' of List 1 responses during List 2 learning than that provided by the Barnes and Underwood MMFR technique remains to be

given.

In an experiment by Jung (1970), List 1 was partially learned before the second task was begun using the A-C paradigm. The first list was continuously reinstated as the second list was being learned. In spite of the continuing presence of the first list, the second list was learned. Jung suggested that the first task was relatively overlearned before the second-list learning was initiated. He commented that this condition, in fact, more closely approximated what happens in transfer tasks outside the laboratory and that a process other than extinction must be sought to explain how alternating lists can be learned without continually unlearning one list in order to learn the other.

Since Jung, in finding results directly contradictory to the Barnes and Underwood conclusion about the 'fate' of first-list responses, speculates that his data was influenced by the relative overlearning of the first list prior to the learning of the second list, designs using overlearning or degree of learning will be examined.

#### Degree of Learning Studies

The degree of first-list learning has been extensively studied as one of the variables influencing transfer (Atwater, 1953; Briggs, 1954, 1957; James & Greeno, 1970; Jung, 1962; Mandler & Heinemann, 1956; Postman, 1962c; Solso, 1969; Spence & Schulz, 1965; Thune & Underwood, 1943; Underwood, 1951). In these studies, overlearning or degree of learning has been defined in relative terms as anything ranging from 1 to 100% overlearning of the first list and in absolute terms as anything ranging from 1 to 100 trials of overlearning of the first list.

A number of these studies are directly relevant to the present study.

Mandler and Heinemann (1956) studied overlearning using three-place consonant nonsense syllables as responses and single integer numbers as stimuli. Ss were required to pronounce the three letters when responding. They used 10 groups with 5 degrees of training. The training task consisted of four paired-associates learned to a criterion of one errorless trial plus five degrees of overlearning, 0, 10, 30, 50, and 100 trials, absolute values not based on the number of trials S required to reach one errorless trial. The transfer task consisted of a mixed list of eight paired-associates, two pairs representing each condition. The paradigms studied were A-B, A-C; A-B, C-B; A-B, A-Br; and A-B, C-D, the last named being the control group. The criterion for the transfer task was two errorless trials or 20 trials, whichever came last. Mandler and Heinemann concluded from their data, based on percentages of errors in each condition, that the 50- and 100-trial conditions provided training beyond the establishment of stable S-R connections. They found there was no consistent negative or positive transfer for A-C, increasing positive transfer with increasing degree of first list learning for C-B and increasing positive transfer with increasing degree of first-list learning for A-Br. Further, A-Br showed a significantly higher degree of positive transfer than C-B.

The Mandler and Heinemann findings are contrary to subsequent findings. Both Jung (1962) and Postman (1962c) found negative transfer for A-C with Postman finding increasing then decreasing negative transfer for this condition. Both found maximum negative transfer for A-Br.

Since Postman's study will be used subsequently in this paper to assess the meaningfulness parameter, it is useful to examine this study further here.

Postman (1962c) looked at the degree of first-list learning and experimental paradigm. His purpose was to measure transfer as a function of degree of first-list learning and relations between stimuli and responses. He defined massive first-list learning as 10/10 + 50% overlearning and used a standard MMFR questionnaire to collect his data. Postman's results showed that all paradigms, A-C, A-Br, and C-B yielded negative transfer effects. The amount of negative transfer was greatest for A-Br, intermediate for A-C, and least for C-B. Performance on the second list improved as a function of degree of first-list learning but amounts of transfer did not change reliably. There was some evidence of progressive increases in negative transfer in A-Br relative to the other conditions. A-C increased in negative transfer and then decreased but there was no significant difference in amount of transfer. Results from the MMFR questionnaire showed that amount of negative transfer and extinction of first-list associations tended to be directly related.

Postman concluded that for the A-Br paradigm, the positive factor of response learning is exceeded by the detrimental effects of associative interference since the strength of backward and forward associations increases with overlearning. He pointed out further that differentiation of list membership develops slowly for the A-Br paradigm and is slowed further by overlearning.

It is true that relative to other paradigms Postman tested with the exception of C-B, that the response learning stage is a positive

factor for A-Br since responses are the same as for the first list. However, Postman used meaningful adjectives as responses so that the response learning stage was short for all paradigms including the C-D control condition. This gave A-Br little advantage because the response components were probably well integrated prior to the experiment.

With meaningful responses, Ss in Postman's study took an average of 15 trials for first-list learning. With massive overlearning defined as a relative value,  $10/10 + 50\%$ , Ss were given an average of seven trials for overlearning. Considering the absolute value used by Mandler and Heinemann, 50 and 100 trials, which produced stable, integrated responses, it is reasonable to question how stable Postman's first-list associations were. If negative transfer reflects the strength of competing responses, associative interference should increase directly with degree of first-list learning. However, list differentiation should also increase directly with degree of first-list learning. Given a stable first-list produced by a more stringent definition of overlearning, list differentiation could cancel out associative interference. Postman stated that the relative weights of response competition and list differentiation would determine an increase or decrease in negative transfer but concluded that there is ". . . no reason, however, to expect the specific transfer effects to shift from negative to positive" (Postman, 1962c, p. 110). This conclusion, evidently based on his own data, is derived from a design which defines overlearning in a limited way. There may still be a question as to

whether a shift from negative to positive transfer would occur with a well-integrated first-list associative system.

There may be some question about the mixed list design used by Mandler and Heinemann (1956) relative to studies which showed contradictory results (Jung, 1962; Postman, 1962c). The transfer task consisted of eight paired-associates, two each for each condition. This meant that there was a ratio of two pairs for the control condition to six pairs for the other conditions. Though Twedt and Underwood (1959) demonstrated the equivalence of the transfer effects produced by the A-C and other transfer paradigms under mixed and unmixed list procedures, Battig (1965) has shown that by using an A-C paradigm and shifting the ratio of A-C pairs to C-D control pairs from two for A-C and six for C-D through four-four to six-two respectively, transfer on A-C shifts from positive to negative. The results for A-C in the Mandler and Heinemann study may reflect this ratio effect.

Further, Ss, utilizing an 'isolation effect' noted by Battig and Barry (1966), may attend first to A-Br pairs since they recognize them immediately, then to C-D control pairs since they are new, and only after that to A-C producing the characteristic negative transfer effect in spite of overlearning. This could account also for the positive results for the A-Br paradigm.

One more point should be noted. Recent studies (James & Greeno, 1970; Underwood, Freund, & Jurica, 1969) suggest that varying the number of paired-associates or the number of responses in an unmixed list produces differential effects in transfer. The discrepancy between the number of paired-associates used in the Mandler and Heinemann study, two

pairs for each condition, and subsequent studies may be in some way producing the difference in results.

Solso (1969) studied response meaningfulness (m) and overlearning in a mixed list design using two levels of learning and two levels of m. After three transfer trials, A-Br showed positive transfer relative to C-D for both levels of m and both levels of degree of first-list learning. Solso introduced a new factor in addition to Postman's four factors (1962) to analyze and explain his results. These include: a) learning to learn; b) response learning; c) associative interference; d) list differentiation; and e) Solso's fifth factor, tactical learning.

Solso suggested that the relative influence of these transfer factors throughout List 2 practice may change within the second list. Associative interference is likely to be strongest during initial transfer but to deteriorate as a dual function of m and non-reinforcement. He proposed that Ss employ different learning tactics throughout transfer learning relative to the hypothesized modulation of associative interference. In Solso's mixed list design, if Ss with first-list overlearning find C-D pairs difficult to learn, then they will attend to A-Br pairs in which they may not only transfer response items but also inhibit first-list associations. This 'singling out' process would be somewhat comparable to Battig and Barry's "isolation" effect (1966) though now, according to Solso, Ss single out A-Br pairs instead of C-D pairs with low-m responses. The data supported the hypothesis that tactical activity would produce a net result in reducing negative transfer effects of associative interference common in the A-Br paradigm.



Inhibition and extinction may be operating at different periods and with different relative strengths throughout second-list learning. He suggests that even more arduous first-list learning may overcome negative transfer characteristics of A-Br paradigm.

The same questions may be raised about Solso's mixed list design as were raised about Mandler and Heinemann's (1956) design. The fact to be underlined here, however, is that Solso did replicate Mandler and Heinemann's results using his low-m responses and produced results contradictory to Postman's (1962c) results using his high-m responses. Solso differed from Mandler and Heinemann in his definition of overlearning. He used the relative measure of  $9/9 + 100\%$  whereas Mandler and Heinemann used absolute measures of 0, 10, 30, 50, and 100 trials of overlearning which, according to their data, produced well integrated lists. There is reason to believe, that first-list learning defined in absolute terms might produce positive transfer throughout second-list learning in the A-Br paradigm.

Jung (1970) studied transfer effects under conditions of preventing unlearning of first-list associations by alternating first- and second-list learning. In this way, first-list learning was kept more or less constant. First-list learning was carried to a criterion of 6/9. Then second-list learning was introduced and presented for six trials in single alternation with six trials of the reinstated first list. There was a significant difference between the experimental and control conditions with a mean of 10.2 correct responses for A-C as compared to 24.7 for C-D. However, though this represented considerable interference from the reinstatement of the first-list, the reverse

was not true. There was no significant difference in performance on the six reinstated trials of the first list.

It appears that in those studies in which first-list learning is carried beyond a criterion of one perfect trial, results are not in complete accord with each other and with studies using a criterion of one perfect trial. They are also difficult to interpret in terms of an interference-extinction theory.

It may be that the interference-extinction theory may relate to a narrowly specified design using the criterion of one perfect trial. If so, this could account for the growing evidence mentioned previously that the interference-extinction theory does not adequately predict extra-laboratory transfer results, since transfer tasks outside the laboratory are ordinarily preceded by massive repetitions of a first task resulting in a well-learned first task prior to the introduction of a second task.

In addition, some studies which vary response meaningfulness using a criterion of one perfect trial and some studies which vary both response meaningfulness and overlearning produce transfer results which are not adequately predicted nor explained using the interference-extinction hypothesis. In a study using the A-C paradigm, low-m trigrams yielded barely negative transfer and high-m trigrams produced very negative transfer (Jung, 1963). Negative transfer gradually increased over three levels of m, low, medium, and high, with high-m materials producing the greatest negative transfer (Merikle & Battig, 1963). Jung (1963) concluded that the learning of List 2 A-C associations appear to be more subject to interference from the reinstatement

of List 1 A-B associations when the responses are high in meaningfulness. He was unable to account for why these results occurred contrary to his predictions.

A closer look at Jung's study provides some insight into why low-m responses produce less associative interference on the transfer task and less negative transfer relative to the high-m responses. The mean number of trials to criterion on List 1 for high-m was 10.50 as compared to 23.45 for low-m for A-C. The differences for all three paradigms in the study are significant as a function of level of m but not as a function of paradigms. Paired-associate first-lists using low-m responses take significantly more trials to criterion than first lists using high-m responses. Though paired-associate learning has two stages, a response learning stage and an association learning stage (Underwood, Runquist and Shulz, 1959; Postman, 1963), Martin (1965) has pointed out that as soon as one element of a paired-associate is learned, it begins to associate with the other pair. This is confirmed in research (Crothers, 1962; Wichawut & Martin, 1971). Not only is there a response learning stage in which all responses are learned prior to the associative learning stage, but also, during that response learning stage elements of the response are associating with the stimulus. Low-m trigrams, with their longer response learning stage have a longer association learning stage embedded in the learning of responses. Response elements are being associated with the stimulus even as responses are still being integrated. Conceptually this would be viewed as three stages: 1) a response learning stage in which single elements of a trigram are integrated into a unit; 2) an intermediate,

overlapping stage in which response elements are being associated with the stimulus; and 3) an association learning stage following on the learning of all response units in which the response unit is associated with the stimulus and becomes a paired-associate.

Such overlapping associative learning would lend an advantage to low-m material relative to high-m material. Stronger associations would be formed via the associative learning overlap since low-m responses take longer to learn than high-m responses. The paired-associate with a low-m response would be more resistant to extinction and in addition, for such a list of paired-associates, list differentiation would develop early in transfer. Since it is the relative weights of list differentiation and associative interference which are directly related to positive transfer, reduced negative transfer, or massive negative transfer (Postman, 1962), low-m trigrams would predictably result in less negative transfer than high-m trigrams.

This interpretation is not in accord with Jung (1968) who, in attempting to explain his 1963 results, suggested that because high-m responses are learned quickly, S passes through the response learning stage quickly and is able to concentrate on the association stage. Thus, Jung said, stronger first-list associations are formed for high-m responses and provide more interference during second-list learning. This in turn results in greater negative transfer. Yet Postman (1963) has shown that decreasing negative transfer is directly related to increasing recall of first-list associations and both are related to over-learning on the first list.

With the foregoing analysis in mind, the contradictory results

within studies and across studies using the A-C paradigm appear to be reconciled. When comparisons are made of the studies in which  $\underline{m}$  is varied (Jung, 1963), degree of learning is varied (Mandler & Heinemann, 1956; Postman, 1963) and both  $\underline{m}$  and degree of learning are varied (Solso, 1969), there is a continuum of results from relative massive negative transfer to decreasing negative transfer (Jung, 1963; Postman, 1963) to neutral transfer (Mandler & Heinemann, 1956) to positive transfer (Solso, 1969). This appears to be directly related to amount of first-list overlearning of associations either in designs specifically examining the degree of learning parameter or in designs which used level of  $\underline{m}$  in which overlearning or underlearning of first-list associations are embedded. In addition, decreasing negative transfer is directly related to increasing recall of first-list responses both of which are a function of amount of first-list learning (Postman, 1963). Even with high meaningful responses, at the highest degree of learning negative transfer decreases. Further, first-list associations are more available. These findings contradict Jung's findings (1963) for high- $\underline{m}$  with a criterion of one perfect trial for List 1 and also contradict his explanation (Jung, 1968) that high- $\underline{m}$  produces stronger associations and, hence, greater interference on the transfer task relative to low- $\underline{m}$ .

It appears that contradictory results in the studies reviewed are more readily reconciled when the relative stability of List 1 associations is examined than when the interference-extinction hypothesis is invoked.

No study has examined specifically the effect of stable, well-integrated List 1 associations on transfer performance and the 'fate' of

first-list associations during learning on the transfer task.

### Statement of the Problem

In paired-associate learning, Barnes and Underwood (1959) found that as a second list was being learned, response items from List 1 were being extinguished. Extinction of response items from List 1 as List 2 is being learned is generally accepted as the 'fate' of first-list in transfer theory.

Yet, in a review of the literature on transfer, it appears that interference-extinction theory may account for or predict results obtained from narrowly specified designs: 1) the extinction hypothesis has been found to be inadequate in accounting for results in extra-laboratory tasks (Jung, 1968; Postman, 1963a; Underwood & Ekstrand, 1966); 2) those studies which involve meaningfulness of material and/or degree of learning have produced contradictory results (Jung, 1970; Mandler & Heinemann, 1956; Merikle & Battig, 1963; Postman, 1962; Solso, 1969); 3) the MMFR technique for collecting recall data may not be sensitive to the recording of partial responses which may still be available after nominal responses become unavailable; and, 4) the influence of the parameters of degree of learning and meaningfulness of material have not as yet been theoretically explained (Martin, 1965).

The study which gave the firmest support to the extinction hypothesis (Barnes & Underwood, 1959) used the criterion of one perfect trial for first-list learning. But overlearning studies show that, after one perfect trial is reached, initial overlearning trials of the first list, begun immediately after reaching the criterion of one perfect trial, do not yield perfect performance. It is only after a num-

ber of first-list overlearning trials are completed that stable, consistent performance is achieved. A criterion of one perfect trial would seem to allow for only a partially present first list even before associative interference and the postulated extinction can occur on the first transfer trial. It follows that the measurement of transfer effects in such a study, that is, the effects of stimulus and response inter-list relationships, is the measurement of the effects of an inconstant and indeterminate variation in the quantity and quality of inter-list relationships. Since extra-laboratory tasks frequently involve overlearning and stability on the first task prior to learning on the second task, a theory of extinction based on studies using a criterion of one perfect trial should be found to be inadequate when applied to extra-laboratory tasks. No transfer studies have been explicitly designed to control for such indeterminate and unmeasurable variation of the crucial variables.

In those meaningfulness and/or degree of learning studies which produced positive transfer effects for A-Br (Mandler & Heinemann, 1956; Solso, 1969) and neither clearly positive nor clearly negative effects for A-C (Mandler & Heinemann, 1956), the use of overlearning and level of m contributed in effect to the stability of the first list. However, since these two studies used mixed-list designs with only two pairs for each paradigm, their results cannot be cited as firm evidence of transfer effects produced by first-list stability.

In those studies which produced negative effects for A-Br and A-C (Jung, 1962; Postman, 1962c), the use of meaningful material and a less stringent definition of overlearning than the previous two studies

cited may have failed to produce the necessary constancy of the first list needed to study processes involved and to measure effects specific to inter-list relationships.

The common technique used for testing the interaction between first-list availability and transfer effects has been either the MFR technique (Briggs, 1954, 1957) or the MMFR technique (Barnes & Underwood, 1959; Postman, 1963; Solso, 1969). These techniques may not be sensitive enough to determine availability of partial or sub-threshold responses. The MFR technique calls for only one nominal response from List 1 or List 2. It does not allow for a second response even if that response were available. The MMFR technique calls for two nominal responses, one from List 1 and one from List 2. It allows for both responses to be given if they are available and thus remedies the inadequacy of the MFR. However, in allowing for and crediting only the two nominal responses from both lists, it fails to test for the availability of partial responses from List 1 during the acquisition of List 2.

The present study attempted to incorporate improvements in the designs of these studies. An absolute value of 15 trials of overlearning was used to define massive overlearning. This value was arrived at by doubling Postman's average of seven trials of overlearning. Low-m nonsense trigrams were used as learning materials. Such trigrams take longer to integrate and are more resistant to extinction. Both of these techniques used together were calculated to produce a stable, well-integrated and constant first-list response and association system.



An unmixed list with eight paired-associates for each paradigm was used to obviate differential results produced by a) the ratio effect of number of pairs in the control group as compared to number of pairs in each condition and b) varying the number of pairs from more than six pairs to six pairs and fewer.

Finally, a modification of the MMFR technique (3MFR) was used to collect recall data on the first list in an effort to use an instrument sensitive to the presence of partial responses which would testify to the continuing availability of first-list responses.

The present study was designed to examine the effect of well-integrated first-list paired-associates and the 'fate' of first-list associates during the learning of a second list. It was predicted that massive overlearning produces significantly better performance on the transfer task relative to nominal learning and that recall of the first list does not extinguish as transfer trials increase.

## CHAPTER II

### METHOD

The effect of a stable, well-integrated first list on transfer and first-list recall was examined using three transfer paradigms: A-B, A-C; A-B, A-Br; and A-B, C-D. The establishment of an adequately integrated first-list response and association system was attempted by using low-m trigrams and massive overlearning defined as 8/8 + 15 trials.

#### Lists

Prior to the experiment, 60 Ss equally distributed among the three paradigms learned paired-associate lists of about 20%-30% AV (Archer, 1960) CVCs for both S and R terms. The purpose of this initial study was to determine whether acquisition lists to be used in the experiment were of equal difficulty.

Acquisition lists for each paradigm and the single transfer list for all paradigms contained eight paired-associate low meaningful CVCs of about 20%-30% AV. The lists were randomly ordered with three different orders of presentation for each list. Both S and R terms had identical or approximately equal AVs. Formal similarity was as low as possible.

#### Subjects

Subjects were 144 college students enrolled in psychology courses. Twelve conditions were randomized in blocks of four and subjects were assigned to these conditions as they appeared in the laboratory. The twelve conditions were all possible combinations of two degrees of first-list learning, massive overlearning defined as 8/8 + 15 trials (MOL)

and underlearning defined as 8/8 (UL); three paradigms (A-B, C-D; A-B, A-C; A-B, A-Br); and two degrees of transfer learning (3 trials and 6 trials).

### Procedure

Standard paired-associate instructions were read to Ss who were asked to spell their anticipated Rs. Lists were presented on a Stowe drum at a 2:2 rate and a 4 sec. inter-trial interval. All Ss were required to reach a criterion of one perfect trial on List 1. Following the one perfect trial all Ss were given a 2 min. rest period. Then all Ss in the MOL condition learned List 1 for an additional 15 trials. Ss in the UL condition were started on the transfer task. Ss in MOL, after completing 15 trials beyond one perfect trial, were given a 2 min. rest period and were then started on the transfer task.

Each of three groups corresponding to the three paradigms for both degrees of first-list learning practiced List 2 for three or six trials. This constituted six sub-groups for MOL (C-D<sub>3</sub>, C-D<sub>6</sub>; A-C<sub>3</sub>, A-C<sub>6</sub>; and A-Br<sub>3</sub>, A-Br<sub>6</sub>) and six sub-groups for UL (C-D<sub>3</sub>, C-D<sub>6</sub>; A-C<sub>3</sub>, A-C<sub>6</sub>; and A-Br<sub>3</sub>, A-Br<sub>6</sub>). When Ss in each sub-group completed either three or six trials on List 2, they were given the 3MFR test for response recall of List I.

The 3MFR test for the A-C and A-Br paradigms contained the eight stimulus items from their respective first lists which were identical with their respective second lists. These stimulus items had four blanks after each item. The 3MFR test for the C-D paradigm contained 16 stimulus items with four blanks after each item since the eight stimuli in List 2

were different from the stimuli in List 1.

S were requested to write down any responses from List 1 or List 2 which came to mind in response to a particular stimulus. They were told that if they did not remember a complete response, they could write down any fraction of a response, that is, a letter or symbol of that response, in the last two blanks. They were told further that if the fractional response helped them to remember the whole response, they should write the fractional responses in the last two blanks and then fill in the whole response in the first two blanks following the appropriate stimulus. Ss were instructed to write down all responses as the responses occurred to them and not to attempt to recall all responses from one list and then all those from the other list.

All groups were given 4 min. to complete the 3MFR task. Following this, Ss were told to go through the responses they had written and to indicate from which list the responses came by writing 1 or 2 before a response. Ss were instructed further to write any additional responses which occurred to them while they were assigning numbers.

After Ss had completed the 3MFR, they were given a matching test for associative recall. For the matching tests for all paradigms, stimuli were presented in one column and responses were presented in a second column. For the C-D paradigm, since the stimuli and responses are different for List 1 and List 2, the stimulus column contained 16 stimulus items and the response column contained 16 response items. The stimulus items were preceded by numbers from 1 to 16 and the response items were preceded by blanks. Ss were instructed to show the correct pairing of stimulus and response items by writing the number of the

stimulus item in the blank preceding the response item with which it was associated.

For the A-C paradigm, since stimuli are the same for List 1 and List 2 and responses are new for List 2, the stimulus column contained 8 stimulus items and the response column contained 16 response items. The stimulus items were preceded by numbers from 1 to 8 and the response items were preceded by blanks. Ss were instructed to show the correct pairing of stimulus and response items by writing the number of the stimulus item in the blank preceding the response item with which it was associated. Ss were reminded that each number would be used twice for the pairings from List 1 and List 2.

For the A-Br matching tasks, since both stimuli and responses are the same for both lists, the stimulus column contained 8 stimulus items and the response column contained 8 response items. The stimulus items were preceded by numbers from 1 to 8 and, since the response items were the same for both lists, but re-paired, the response items were preceded by two blanks. Ss were instructed to show the correct pairing of stimulus and response items from List 1 and List 2 by writing the number of the stimulus item in the blank preceding the response item with which it was associated. Ss were reminded that each number representing a stimulus item would be used twice and that each response item required two blanks to show the pairings of the response with two different stimulus items.

Ss were given 4 min. to match items. Following the completion of the matching test, Ss were told to go through the matched pairs and to

indicate from which list the pairing came by writing 1 or 2 after the matched pair. Ss were instructed further to write down any additional matching which occurred to them while they were assigning numbers.

## CHAPTER III

### RESULTS

#### First-list Learning

The over all mean for all groups on number of trials to reach a criterion of one perfect trial was 33.2 with a range of means from 31.5 to 34.0. There was no significant difference among groups on trials to criterion for first-list learning ( $F = .047$ ,  $df = 2/141$ ).

#### Transfer Effects

Table 1 presents the means and standard deviations for correct responses for transfer performance for all 12 conditions (two degrees of learning: massive overlearning (MOL) and underlearning (UL); three paradigms: C-D, A-C, and A-Br; number of transfer trials: three and six trials). Table 2 presents the  $2 \times 3 \times 2$  analysis of the data in Table 1.

Degree of learning shows a significant main effect ( $F = 10.94$ ,  $df = 1/132$ ,  $p < .01$ ). As anticipated, Ss who practiced the first list for fifteen trials beyond one perfect trial (MOL) showed better performance on the transfer task than Ss who practiced the first list to a criterion of one perfect trial.

The number of trials practiced on the transfer task (List 2) also showed a significant main effect as would be expected ( $F = 91.04$ ,  $df = 1/132$ ,  $p < .001$ ). Ss who practiced for six transfer trials gave more correct responses overall than Ss who practiced for three trials.

TABLE 1  
Means and Standard Deviations for Correct Responses  
on Transfer After 3 or 6 Trials

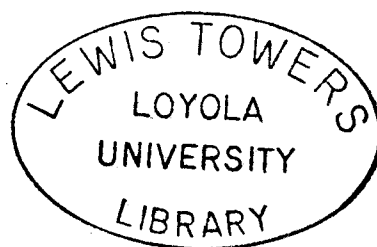
Trials and Degrees of Learning		Paradigms					
		A-C		A-Br		C-D	
		$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
MOL	3	.83	.28	2.58	1.61	1.58	1.38
	6	6.50	3.35	11.08	5.74	6.00	3.46
UL	3	1.42	.95	1.00	.82	1.42	1.38
	6	4.83	5.12	5.67	2.00	4.08	2.96



TABLE 2

Summary of Results of 2 X 3 X 2 Analysis of Transfer Data

Source	Sum of Squares	df	Mean Square	F
Between Groups				
Main Effects				
Degree of Learning (DOL)	103.3610	1	103.3610	10.9368**
Paradigm (P)	98.3749	2	49.1874	5.2046**
Trials (T)	860.4443	1	860.4443	91.0455***
Interaction Effects				
DOL X P	60.8015	2	30.0907	3.1839*
DOL X T	61.3611	1	61.3611	6.4927*
P X T	57.6804	2	28.8402	3.0516*
DOL X P X T	7.0975	2	3.5487	.3754
Within Groups	1247.5003	132	9.4507	
Total	2496.0000	143		

\*  $p < .05$ \*\*  $p < .01$ \*\*\*  $p < .001$ 

Paradigms also showed a significant main effect ( $F = 5.20$ ,  $df = 2/132$ ,  $p < .01$ ). Ss who practiced on the A-Br paradigm gave the greatest number of correct responses on the transfer task, with the A-C paradigm next highest, and the C-D paradigm the least number of correct responses learned.

The interaction between paradigms and degree of learning was significant ( $F = 3.18$ ,  $df = 2/132$ ,  $p < .05$ ). With the number of correct responses combined for three and six transfer trials, Ss who overlearned List 1 were superior in performance on transfer to Ss who learned to a criterion of one perfect trial for all paradigms with A-Br obtaining the highest number of correct responses, C-D the next highest and A-C the lowest in the MOL condition. In the UL condition, though all paradigms were inferior in performance to paradigms in the MOL condition, A-Br again had the highest number of correct responses but C-D and A-C reversed positions with C-D showing the least number of correct responses.

Degree of learning  $\times$  trials significantly interacted ( $F = 6.49$ ,  $df = 1/132$ ,  $p < .05$ ). Though for both degrees of learning more correct responses were obtained on the sixth trial than on the third trial, inspection of the data revealed that overlearning produced a more rapid acceleration of learning from the third to the sixth trial than did underlearning for all paradigms.

The paradigms  $\times$  trial interaction was also significant ( $F = 3.05$ ,  $df = 2/132$ ,  $p < .05$ ). Though all paradigms showed more correct responses on the sixth trial than on the third trial, the A-Br paradigm showed a greater number of correct responses than either C-D or A-C on both trials

and in addition showed more rapid learning from the third to the sixth trial than either C-D or A-C. Further, though learning proceeded more slowly for A-C relative to C-D and A-B<sub>r</sub> up to the third trial, learning accelerated relative to C-D so that A-C and C-D reversed positions on correct number of responses for six transfer trials. Figure 1 presents this graphically.

### Interlist Intrusions

Interlist intrusions were so few that no analysis was carried out.

### Modification of Modified Modified Free Recall (3MFR) Data

Since too little data was generated from the 3MFR, no statistical analysis could be carried out.

### Modified Modified Free Recall (MMFR)

The means and standard deviations for all recall data are given in Table 3.

The summary of results of the  $2 \times 3 \times 2$  analysis for List 1 is contained in Table 4. The graphic representation is shown in Figure 2. Recall data for MMFR List 1 showed a significant main effect for degree of learning ( $F = 18.75$ ,  $df = 1/132$ ,  $p < .01$ ). As expected, massive overlearning produced better recall of List 1 responses than underlearning. The degree of learning  $\times$  trials was also significant ( $F = 7.89$ ,  $df = 1/132$ ,  $p < .01$ ). Ss who practiced the first list to the criterion of one perfect trial before starting the transfer task showed declining recall of List 1 responses as transfer trials increased. Ss who overlearned List 1 prior to starting the transfer task showed increasing recall as transfer trials increased.

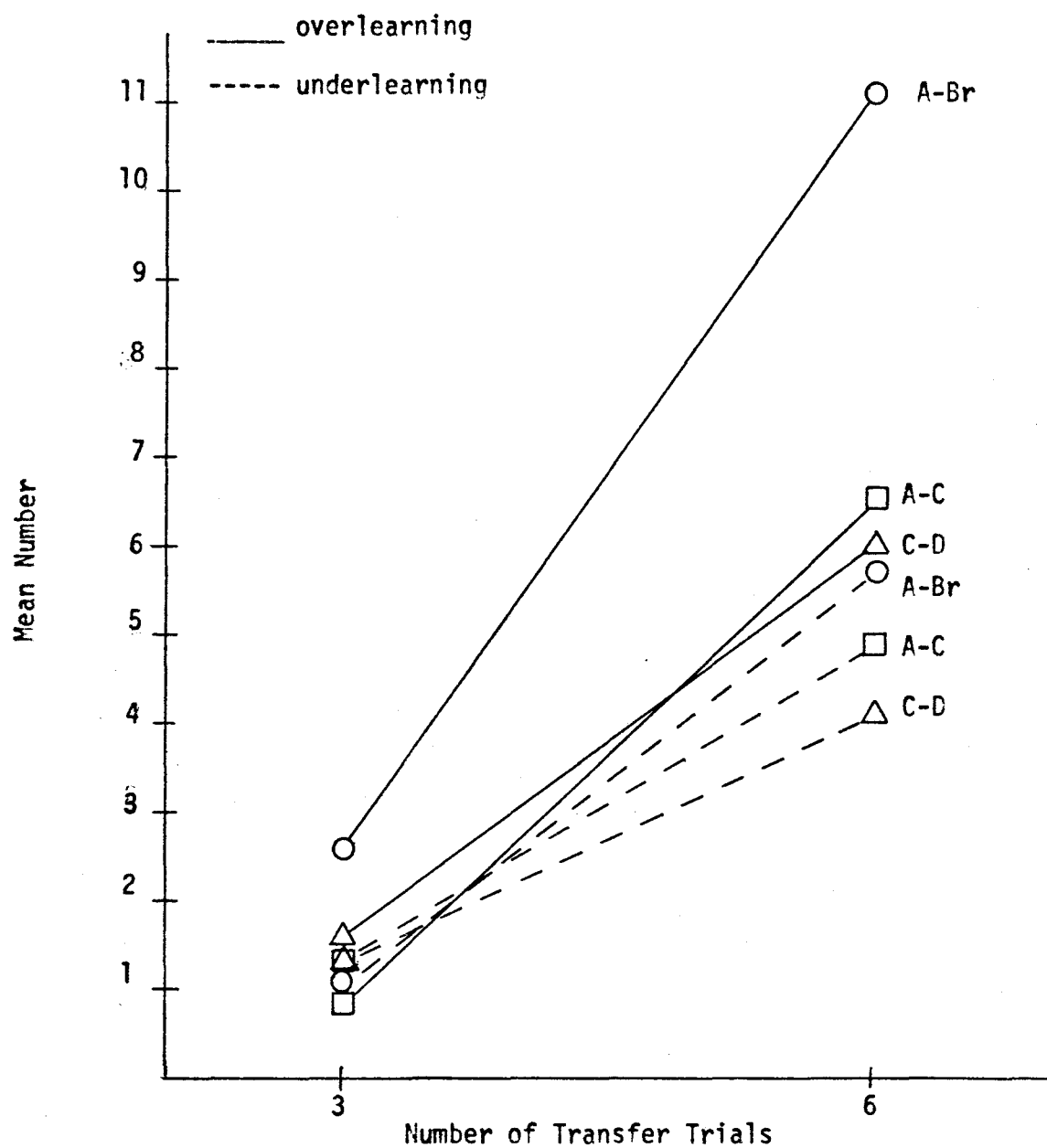


Fig. 1 Mean Number of Correct Responses on Transfer

TABLE 3

Means and Standard Deviations for Correct Responses on MMFR and Matching (M) for 2 Degrees of Learning (MOL and UL) and 2 Units of Transfer Trials (3 and 6 Trials) for List 1 and List 2

Source	Degree of Learning	Type of Recall	Paradigms											
			A-C (II)				A-Br (III)				C-D (I)			
			$\bar{X}$	$\frac{3}{S.D.}$	$\bar{X}$	$\frac{6}{S.D.}$	$\bar{X}$	$\frac{3}{S.D.}$	$\bar{X}$	$\frac{6}{S.D.}$	$\bar{X}$	$\frac{3}{S.D.}$	$\bar{X}$	$\frac{6}{S.D.}$
List 1	MOL	MMFR	6.58	1.99	7.42	.76	7.17	1.21	7.92	.28	6.75	1.21	6.92	1.52
		M	6.50	2.75	7.5	1.19	7.42	.93	8.0	.00	6.58	1.62	7.25	1.16
	UL	MMFR	6.92	.95	5.75	1.83	6.17	1.94	5.83	1.07	6.17	1.69	5.58	1.04
		M	7.00	.91	6.67	1.29	7.08	1.21	6.17	2.18	6.42	1.34	6.0	1.53
List 2	MOL	MMFR	<u>A-C</u>				<u>A-Br</u>				<u>C-D</u>			
		M	1.50	1.50	2.92	1.97	2.67	1.74	4.75	2.77	1.75	.92	3.25	1.96
	UL	MMFR	2.58	1.85	3.58	1.98	2.33	1.84	4.67	2.95	2.67	2.05	4.42	2.21
		M	2.25	1.30	2.58	1.26	.75	.72	2.58	1.39	1.75	1.05	2.08	1.12
			3.00	1.29	3.08	2.30	.92	1.55	2.17	1.57	2.0	2.04	2.67	1.24

TABLE 4

Summary of Results of 2 X 3 X 2 Analysis of MMFR Data for List 1

Source	Sum of Squares	df	Mean Square	F
Between Groups				
Main Effects				
Degree of Learning (DOL)	38.0278	1	38.0278	18.75 **
Trials (T)	.2500	1	.2500	.12
Paradigm (P)	5.2839	2	2.6319	1.30
Interaction Effects				
DOL X T	16.0000	1	16.0000	7.89 **
DOL X P	3.8472	2	1.9236	.95
T X P	.7917	2	.3958	.20
DOL X T X P	2.3750	2	1.1875	.59
Within Groups	267.6667	132	2.0277	
Total	334.2222	143		

\*  $p < .05$ \*\*  $p < .01$

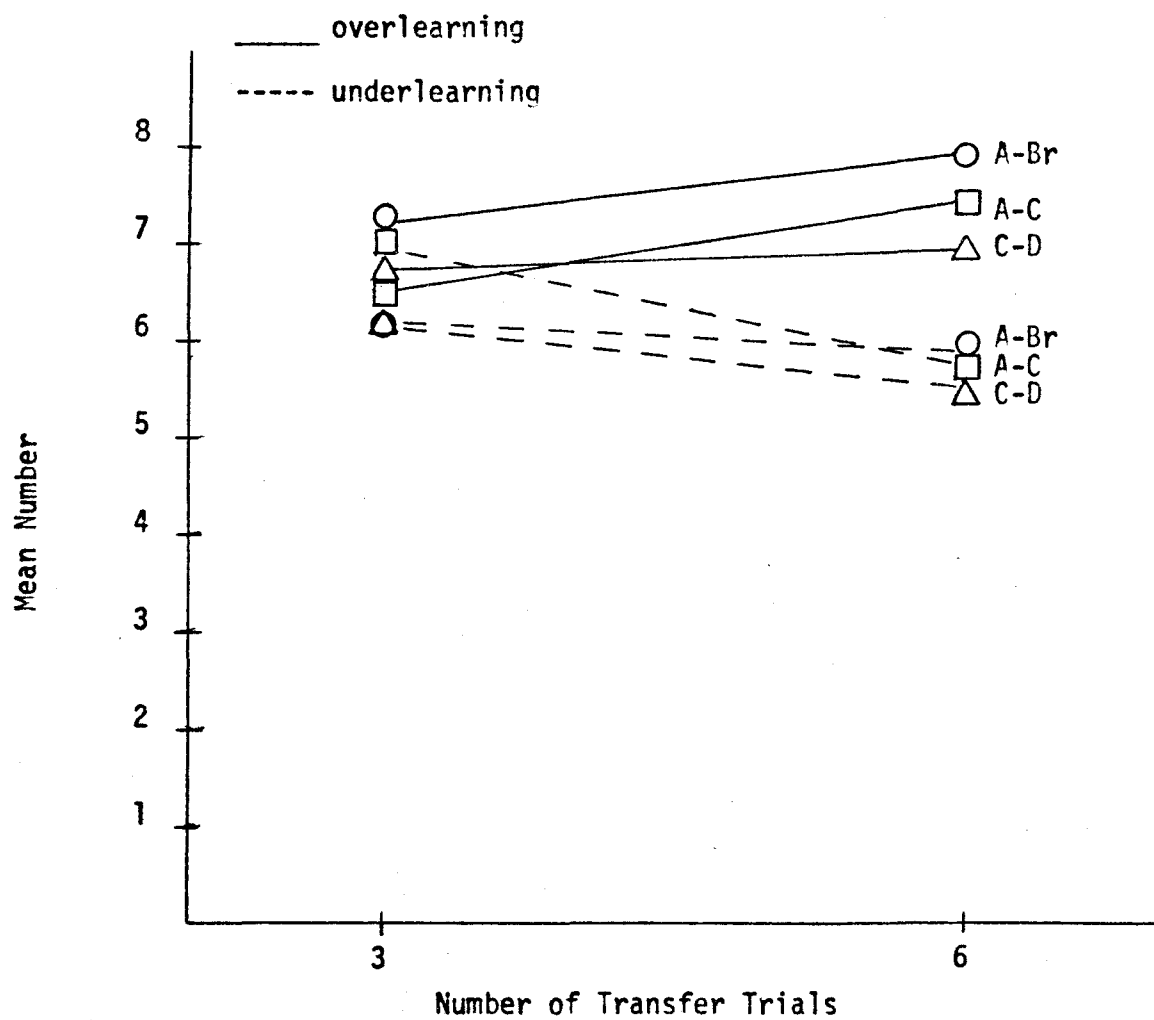


Fig. 2 Mean Number of List 1 Responses Recalled on MMFR  
for Massive Overlearning and Underlearning

The summary of results of the  $2 \times 3 \times 2$  analysis for List 2 is contained in Table 5. The graphic representation is shown in Figure 3. The main effect for degree of learning was significant ( $F = 8.01$ ,  $df = 1/132$ ,  $p < .01$ ). Overlearning produced better recall of List 2 responses relative to underlearning. The main effect for trials was also significant ( $F = 19.29$ ,  $df = 1/132$ ,  $p < .01$ ). As would be expected, more responses were learned by the sixth trial and therefore more responses were recalled.

Degree of learning x paradigm showed a significant interaction effect ( $F = 5.36$ ,  $df = 2/132$ ,  $p < .01$ ). For the underlearning condition A-C showed the best recall of responses with C-D intermediate and A-Br poorest. However, for overlearning, though A-C and C-D maintained the same relative positions, both were somewhat poorer on the number of responses recalled relative to A-Br. Massive overlearning facilitated recall for the A-Br paradigm but did not have a facilitative effect on recall for A-C and C-D.

### Matching

The means and standard deviations for matching data are given in Table 3.

The summary of results of the  $2 \times 3 \times 2$  analysis for List 1 is contained in Table 6. The graphic representation is shown in Figure 4. The main effect for degree of learning was significant ( $F = 6.81$ ,  $df = 1/132$ ,  $p < .05$ ). Overlearning produced better recall of first-list associations than underlearning. There was also a significant interaction effect for degree of learning x trials ( $F = 6.26$ ,  $df = 1/132$ ,  $p < .05$ ).



TABLE 5

Summary of Results of 2 X 3 X 2 Analysis of MMFR Data for List 2

Source	Sum of Squares	df	Mean Square	F
Between Groups				
Main Effects				
Degree of Learning (DOL)	23.3611	1	23.3611	8.01 **
Trials (T)	56.2500	1	56.2500	19.29 **
Paradigm (P)	6.0972	2	3.0486	1.05
Interaction Effects				
DOL X T	6.2500	1	6.2500	2.14
DOL X P	31.2639	2	15.6319	5.36 **
T X P	9.0417	2	4.5208	1.55
DOL X T X P	1.5417	2	.7708	.26
Within Groups	384.8333	132	2.9154	
Total	518.6389	143		

\*  $p < .05$ \*\*  $p < .01$

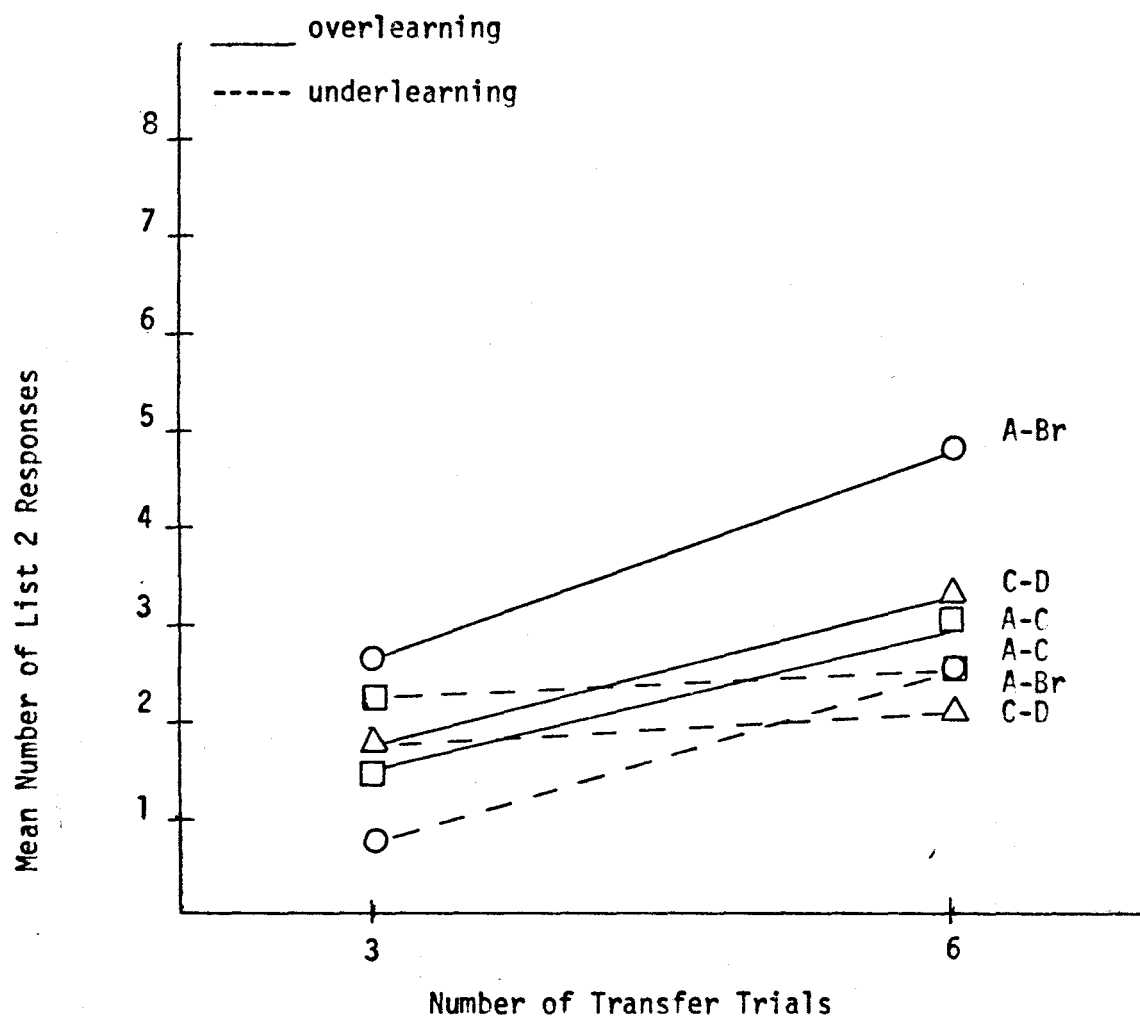


Fig. 3 Mean Number of List 2 Responses Recalled  
on MMFB for Massive Overlearning and Underlearning

TABLE 6

Summary of Results of 2 X 3 X 2 Analysis of Matching Data for List 1

Source	Sum of Squares	df	Mean Square	F
Between Groups				
Main Effects				
Degree of Learning (DOL)	16.0000	1	16.0000	6.81 *
Trials (T)	.4444	1	.4444	.19
Paradigm (P)	9.5000	2	4.7500	2.02
Interaction Effects				
DOL X T	14.6944	1	14.6944	6.26 *
DOL X P	5.1667	2	2.5833	1.10
T X P	1.5556	2	.7778	.33
DOL X T X P	.3889	2	.1944	.08
Within Groups	310.0000	132	2.3484	
Total	357.7500	143		

\*  $p < .05$ \*\*  $p < .01$

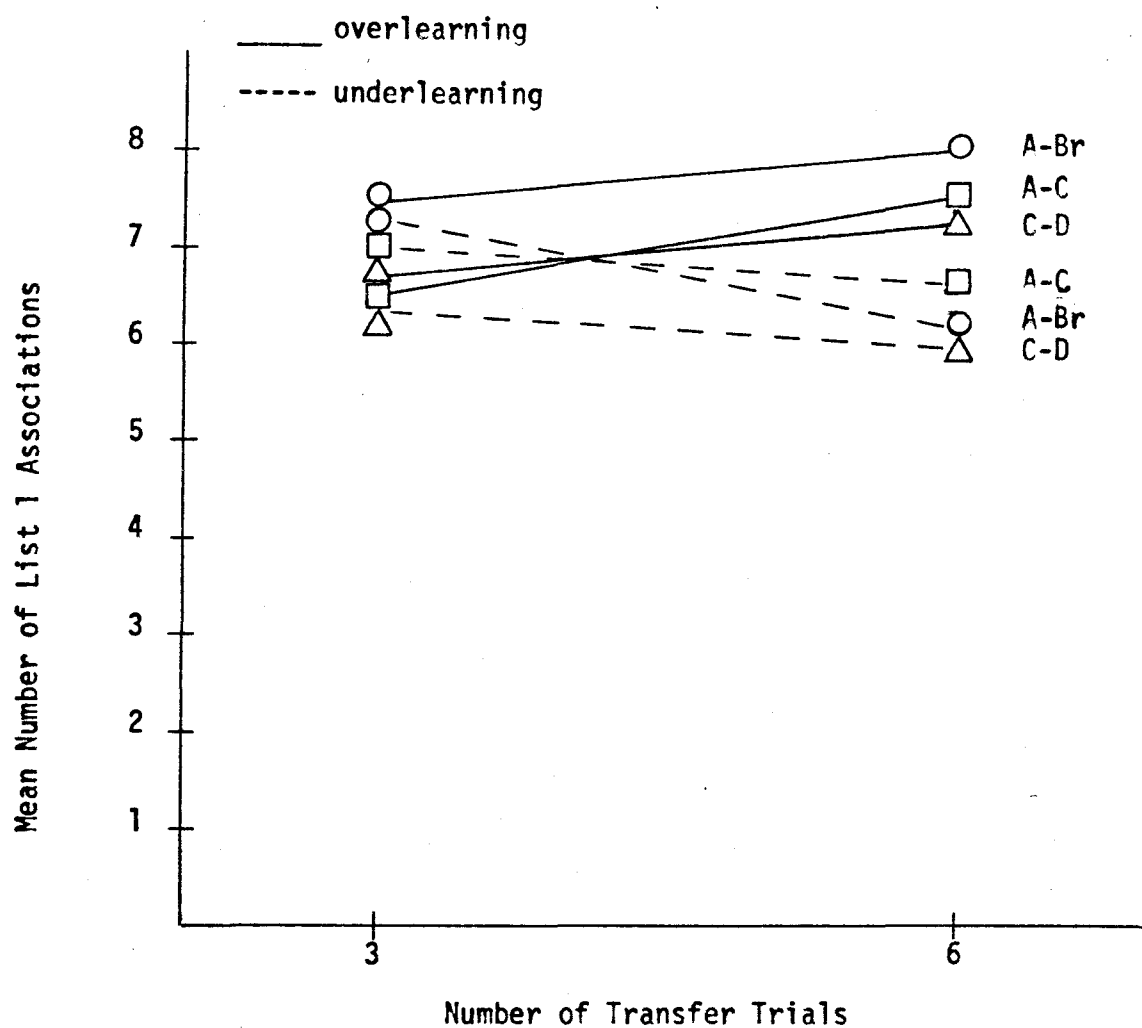


Fig. 4 Mean Number of List 1 Associations Recalled  
on Matching Test for Massive Overlearning and Underlearning

Ss who practiced the first list to the criterion of one perfect trial before starting the transfer task showed declining recall of first-list associations as transfer trials increased. Ss who overlearned the first list prior to beginning the transfer task showed increasing recall as transfer trials increased.

The summary of results of the  $2 \times 3 \times 2$  analysis for List 2 is contained in Table 7. The graphic representation is shown in Figure 5. The main effect of degree of learning was significant ( $F = 9.97$ ,  $df = 1/132$ ,  $p < .01$ ). Overlearning produced better recall of second-list associations relative to underlearning. In addition, there was a significant main effect for trials ( $F = 12.15$ ,  $df = 1/132$ ,  $p < .01$ ). The more transfer trials which were practiced, the better the recall of List 2 associations.

TABLE 7

Summary of Results of 2 X 3 X 2 Analysis of Matching Data for List 2

Source	Sum of Squares	df	Mean Square	F
Between Groups				
Main Effects				
Degree of Learning (DOL)	41.1736	1	41.1736	9.97 **
Trials (T)	50.1736	1	50.1736	12.15 **
Paradigm (P)	7.7222	2	3.8611	.94
Interaction Effects				
DOL X T	9.5069	1	9.5069	2.30
DOL X P	22.3889	2	11.1944	2.71
T X P	9.3889	2	4.6944	1.14
DOL X T X P	.0556	2	.0278	.01
Within Groups	544.9167	132	4.1282	
Total	685.3264	143		

\*  $p < .05$ \*\*  $p < .01$

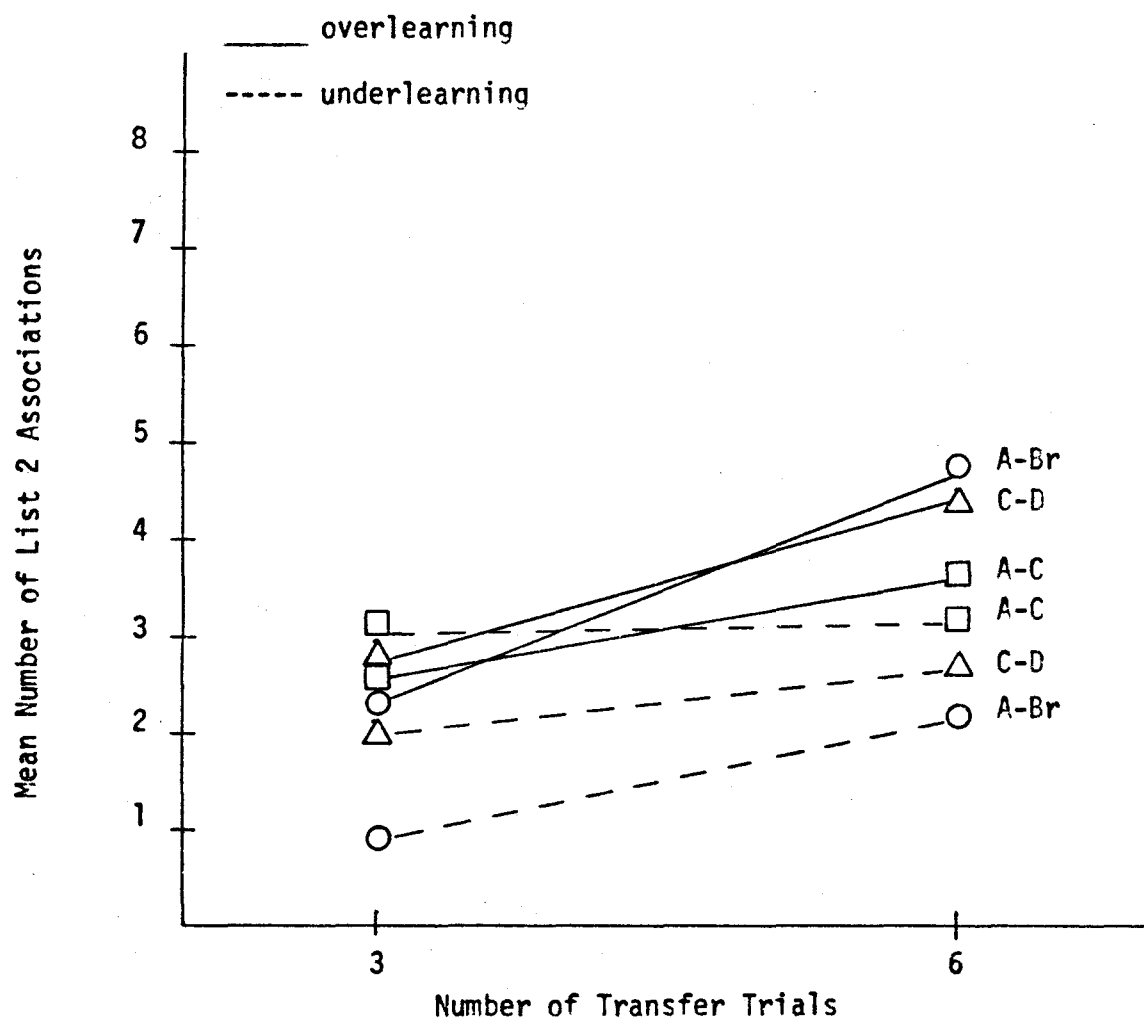


Fig. 5 Mean Number of List 2 Associations Recalled on Matching Test for Massive Overlearning and Underlearning

## CHAPTER IV

### DISCUSSION

The results of the present study support the prediction that a stable first list, produced by massive overlearning of low-m trigrams, yielded superior performance on transfer relative to underlearning defined by a criterion of one perfect trial. Overall transfer performance under conditions of overlearning was significantly better than performance under conditions of underlearning.

The following sources of transfer effects, applied to the two ordinarily negative transfer paradigms, can be used to account for the results: 1) learning to learn and warm-up; 2) response learning; 3) associative interference; and 4) list differentiation. The first factor may be assumed to be equal for all paradigms. The remaining factors produce differential effects depending on the inter-list stimulus and response relationships in each paradigm.

In the A-Br paradigm both stimuli and responses are the same. The second factor, response learning on the first list, should produce superior performance on the second list through response savings relative to other paradigms in which responses are different on the transfer task. This should occur in both the overlearning and underlearning conditions and should have an even greater effect when low-m trigrams are used since learning of such response material is more difficult and takes longer. However, associative interference, the third factor,



ordinarily retards learning in the A-Br paradigm. When the same re-paired stimuli and responses from List 1 appear during List 2 learning they evoke both forward and backward associations from List 1 and these associations contribute a double retarding effect on the learning of List 2. This usually offsets the facilitative effect of response savings.

In addition, the greater the amount of first-list practice, the more interference ordinarily should occur during second list learning. However, under the conditions of this study, in which a stable first-list associative system was established during first-list learning, associative interference was relatively offset through list differentiation, the fourth transfer factor. Contrary to Postman's findings (1962), list differentiation developed early for A-Br and Ss were able to recognize and withhold first-list responses. This reduction of associative interference allowed response savings to produce a facilitative effect on the transfer task.

In Postman's study, even in the condition of highest degree of learning, A-Br showed increasing negative transfer. However, Postman used a relative measure, 10/10 + 50% overlearning of high-m material. The present study used 8/8 + 15 trials of overlearning of low-m material. The criterion for overlearning doubled the average number of trials of overlearning in the Postman study and low-m responses produced a longer response learning stage relative to high-m responses. This methodology was apparently successful in establishing a stable first list and in producing superior performance for A-Br relative to

all other conditions. This finding concurs with Solso (1969).

In the A-C paradigm, responses are different and stimuli are the same in List 1 and List 2. The second transfer factor should transfer no effects. The third transfer factor should transfer associative interference when the same stimulus appears in List 2 and evokes forward associations from List 1. Such interference ordinarily retards learning in the A-C paradigm. In the present study, the fourth factor, list differentiation developed early under conditions of overlearning. Associative interference was relatively offset during List 2 learning and its usually retarding effect was reduced. With associative interference reduced, A-C showed a greater number of correct responses relative to A-C in the underlearning condition and contributed to the overall superior performance in the overlearning condition. The results for the A-C paradigm concur with Mandler & Heinemann (1956) who found neutral or slightly positive transfer with overlearning.

For C-D, more correct responses occurred in the overlearning than in the underlearning condition on transfer. This result cannot be explained in terms of transfer factors since both stimuli and responses are new in List 2.

The main effect for trials and the interaction effect for degree of learning x trials are particularly relevant in interpreting the finding of superior performance on transfer under conditions of overlearning. By the sixth transfer trial, all paradigms for both degrees of learning show more correct responses than for three trials. This would be expected. However, the degree of learning x trials analysis reveals that in the overlearning condition, overall performance for all

paradigms accelerates more rapidly than in the underlearning condition. Massive overlearning is more effective in negating associative interference through list differentiation early in transfer. In addition, A-Br accelerates more rapidly relative to A-C and C-D. This can again be interpreted in terms of transfer factors. With earlier list differentiation resulting from a relatively stable first-list produced by low-m trigrams alone or low-m trigrams and overlearning, associative interference is less effective or counteracted in underlearning and overlearning respectively. Response savings, present only in A-Br, effect more rapid learning.

The results of the present study also support the prediction that a stable first list produced by massive overlearning and low-m trigrams results in no decrease in recall of the first-list responses and associations as transfer trials increase. In addition to significantly better recall of first-list responses and associations for the overlearning condition relative to the underlearning condition, there was a significant interaction between degree of learning and trials. Overlearning produced increasing recall of both responses and associations from the first list and underlearning produced declining recall of first-list responses and associations. The findings for the underlearning condition are in agreement with Barnes and Underwood (1959) who, using a criterion of one perfect trial, found that as transfer trials increase, recall of first-list responses become unavailable.

The findings for the overlearning condition are consonant with Postman (1962). Recall of first-list increases with amount of first-

list learning and is directly related to increasing number of trials on the transfer task.

Both the results of the present study and the results of Postman's study, namely, of a direct relationship between increasing recall of first-list responses and increasing transfer learning is contrary to the inverse relationship proposed by the extinction theory and supported by Barnes and Underwood (1959). The relative weights of associative interference and list differentiation produce an inverse relationship in a design using a criterion of one perfect trial for first-list learning and a direct relationship in designs using overlearning and a relatively stable first list. Postman was unable to give an explanation of this phenomenon. In the present study, the prediction stated only that first-list responses would not decline on a recall task. It is possible that responses are available early in transfer (third trial) but are suppressed due to competition between List 1 and List 2. As differentiation develops quickly (sixth trial) available responses emerge.

The rationale developed in supporting a need for a more sensitive instrument than the MMFR forestalls any adequate explanation of why the 3MFR did not generate data for analysis. The only explanation that can be suggested at this time is that the use of low-m trigrams and massive overlearning created such well-integrated responses that in the underlearning condition there was an all-elements-or-nothing phenomenon. In the overlearning condition, recall of the complete trigram was so uniformly high there was no room for partial responses. Future designs to test the relative sensitivity of the MMFR and 3 MFR could incorporate

both low-m and high-m trigrams and closely graded degrees of learning.

More important future research might be directed toward determining at what point, between a criterion of one perfect trial for first-list and varying degrees of overlearning, the relationship between first-list recall and second list learning changes from inverse to direct. Put another way, under what conditions do first-list responses remain available and under what conditions do they extinguish. This would require varying levels of m, which seems to have degree of associative learning embedded in the response learning stage, and degrees of learning defined as number of trials following a criterion of one perfect trial on first-list learning. The results would produce a matrix of results for transfer and first-list recall which could help to clarify the specific application of the extinction hypothesis and support a theoretical explanation of the influence of degree of learning and meaningfulness reducing them to a single variable.

## CHAPTER V

### SUMMARY

This study investigated the effect of a stable, well-integrated first list on transfer and the 'fate' of first-list responses and associations. Low meaningful trigrams and learning to a criterion of  $8/8 + 15$  trials of overlearning were used to produce a stable first list. Underlearning was defined as learning to a criterion of one perfect trial. Three paradigms were used: A-B, C-D (new stimuli and new responses); A-B, A-C (old stimuli and new responses); and A-B, A-Br (old stimuli and old responses re-paired). Identical second lists were used for all paradigms. First lists were varied to produce the appropriate interlist stimulus and response relationships for each paradigm. Transfer learning continued for three or six trials after which a modification of the modified test of free recall (3MFR) was administered. Following the 3MFR test, a matching test was administered for additional recall data.

The overlearning condition produced significantly superior performance on the transfer task relative to the underlearning condition. In addition, results showed that the overlearning condition facilitated transfer from the third to the sixth trials to a greater extent than did the underlearning condition.

Results from the recall data also confirmed the prediction regarding the availability of the first list during transfer. The recall of first-list responses and associations did not decline as transfer

learning increased. Recall was significantly better in the overlearning condition relative to underlearning.

With an independent first-list association system established during first-list learning using overlearning of low-m responses, list differentiation developed early in transfer, associative interference was relatively offset, and first-list responses and associations were more resistant to extinction compared to results in the underlearning condition.

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## APPENDIX

## MATERIALS USED FOR FIRST AND SECOND LIST LEARNING

## List 1

C-D

KYR-JIK  
CIH-BYQ  
SUW-NAX  
RIJ-KES  
MAQ-WUG  
DOJ-FUP  
GEF-CYB  
QES-HIW

A-C

FIQ-KYR  
NYZ-CAQ  
QED-SUV  
VIH-RUX  
WEF-BYP  
BUW-DAX  
HYB-WUK  
JEV-TUZ

A-BR

FIQ-LOJ  
NYZ-VUC  
QED-XIT  
VIH-QYM  
WEF-ZAH  
BUW-MEF  
HYB-GIY  
JEV-YAD

## LIST 2

FIQ-YAD  
NYZ-ZAH  
QED-VUC  
VIH-LOJ  
WER-QYM  
BUW-GIY  
HYB-MEF  
JEV-XIT

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The dissertation is therefore accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

1/4/74  
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